

What is claimed is:

1. A thermoelectric structure comprising:

- a. a solid metal electrode;
- b. a thermoelement thermally coupled to the solid metal electrode; and
- c. a phonon conduction impeding medium the phonon conduction impeding medium being coupled with the thermoelement, the phonon conduction impeding medium being thermally insulated from the solid metal electrode.

2. The thermoelectric structure in accordance with claim 1 wherein the phonon conduction impeding medium is a liquid metal.

3. The thermoelectric structure in accordance with claim 1 wherein the phonon conduction impeding medium is selected from the group consisting of: gallium, indium, gallium-indium, lead, lead-indium, cesium doped gallium-indium, gallium-indium-copper, gallium-indium-tin and mercury.

4. The thermoelectric structure in accordance with claim 1 wherein the thermoelement is selected from the group consisting of: p-type Bi-Sb-Te, n-type Bi-Te compounds, superlattices of Bi_2Te_3 and Sb_2Te_3 , Bismuth chalcogenides, Lead chalcogenides, complex chalcogenide compounds of Zn, Bi, Tl, In, Ge, Hf, K, and Cs, SiGe compounds, BiSb compounds and skutteridites compounds of Co, Sb, Ni, and Fe.

5. A thermoelectric device comprising:

- a. a first solid metal electrode;
- b. a thermoelement thermally coupled to the first solid metal electrode;
- 5 c. a phonon conduction impeding medium, the phonon conduction impeding medium being coupled with the thermoelement, the phonon conduction impeding medium being thermally insulated from the first solid metal electrode; and
- d. a second solid metal electrode thermally coupled to the phonon
10 conduction impeding medium.

6. The thermoelectric device in accordance with claim 5 wherein the phonon conduction impeding medium is a liquid metal.

15 7. The thermoelectric device in accordance with claim 5 further comprising a dielectric material, the dielectric material maintaining spacing between the first solid metal electrode and the second solid metal electrode.

8. The thermoelectric device in accordance with claim 5 wherein multiple
20 thermoelectric devices are connected electrically in series and thermally in parallel.

9. The thermoelectric device in accordance with claim 6 further including a power source coupled to the thermoelectric device such that the thermoelectric device operates as a thermoelectric cooler.

5 10. The thermoelectric device in accordance with claim 6 wherein a temperature gradient is maintained between the solid metal electrodes such that the thermoelectric device operates as a thermoelectric power generator.

10 11. The thermoelectric device in accordance with claim 6 wherein the first and second solid metal electrodes comprise a multi-layered plate of different metals.

12. The thermoelectric device in accordance with claim 11 wherein the multi-layered metal plate is made of Nickel-plated Copper or Aluminum coated with layers of platinum and TiW.

15 13. The thermoelectric device in accordance with claim 5 wherein the phonon conduction impeding medium is selected from the group consisting of: gallium, indium, gallium-indium, lead, lead-indium, cesium doped gallium-indium, gallium-indium-copper, gallium-indium-tin and mercury.

20 14. The thermoelectric device in accordance with claim 5 wherein the thermoelement is selected from the group consisting of: p-type Bi-Sb-Te, n-type Bi-Te compounds, superlattices of Bi_2Te_3 and Sb_2Te_3 , Bismuth chalcogenides, Lead chalcogenides, complex chalcogenide compounds of Zn, Bi, Tl, In, Ge, Hf, K, and

Cs, SiGe compounds, BiSb compounds and skutteridites compounds of Co, Sb, Ni, and Fe.

15. A thermoelectric device comprising:

- 5 a. a first solid metal electrode;
- b. a first thermoelement thermally coupled to the first solid metal electrode;
- c. a phonon conduction impeding medium, the phonon conduction impeding
 medium being coupled with the first thermoelement, the phonon
 conduction impeding medium being thermally insulated from the first solid
10 metal electrode;
- d. a second thermoelement, the second thermoelement being connected to
 the phonon conduction impeding medium;
- e. a second solid metal electrode thermally coupled to the second
 thermoelement, the second solid metal electrode being thermally insulated
15 from the phonon conduction impeding medium; and
- f. a dielectric material, the dielectric material maintaining spacing between
 the first solid metal electrode and the second solid metal electrode.

16. The thermoelectric device in accordance with claim 15 wherein multiple
20 thermoelectric devices are connected electrically in series and thermally in
 parallel.

17. The thermoelectric structure in accordance with claim 15 wherein the phonon
 conduction impeding medium is a liquid metal.

18. A thermoelectric device comprising:

- a. a first solid metal electrode;
- b. a second solid metal electrode;
- 5 c. a first phonon conduction impeding medium, the first phonon conduction impeding medium being coupled with the first solid metal electrode;
- d. a second phonon conduction impeding medium, the second phonon conduction impeding medium being coupled with the second solid metal electrode;
- 10 e. a thermoelement thermally coupled to the first and second phonon conduction impeding mediums; and
- f. a dielectric material, the dielectric material maintaining spacing between the first solid metal electrode and the second solid metal electrode.

15 19. A method for fabricating a thermoelectric device, the method comprising the steps of:

- a. forming a first base structure, the first base structure comprising a silicon dioxide coated silicon wafer and a first solid metal electrode;
- b. disposing a first thermoelement on the base structure;
- 20 c. disposing a first phonon conduction impeding medium on the first thermoelement;
- d. disposing a second phonon conduction impeding medium on the first metal electrode;

- e. forming a second base structure, the second base structure comprising a silicon dioxide coated silicon wafer, a second metal electrode, a third metal electrode and a second thermoelement, the polarity of the second thermoelement being opposite to the polarity of the first thermoelement;
and
- f. combining the second base structure with the structure resulting after executing step d, the combination resulting in the formation of the thermoelectric device.

20. The method for fabricating a thermoelectric device in accordance with claim 19 wherein the step of forming a first base structure further comprises:

- a. depositing a silicon dioxide layer on the surface of a silicon wafer; and
- b. depositing a composite solid metal electrode structure over the silicon dioxide layer.

21. The method for fabricating a thermoelectric device in accordance with claim 20 wherein the step of depositing a silicon dioxide layer is performed using a technique selected from the group of chemical vapor deposition, plasma enhanced chemical vapor deposition and direct thermal oxidation of silicon wafer.

22. The method for fabricating a thermoelectric device in accordance with claim 20 wherein the step of depositing a composite solid metal electrode structure comprises the steps of:

- a. patterning the silicon dioxide layer;

- b. etching the patterned silicon dioxide layer to form pits in the silicon dioxide layer;
- c. depositing a copper seed layer in the pits;
- d. plating copper onto the seed layers to cover up the pits;
- 5 e. polishing the surface of the plated copper; and
- f. depositing and patterning TiW and platinum layers over the plated copper.

23. The method for fabricating a thermoelectric device in accordance with claim 22
wherein the steps of depositing copper seed layers and depositing TiW and
10 platinum layers are performed by physical vapor deposition.

24. The method for fabricating a thermoelectric device in accordance with claim 22
wherein the step of etching the patterned silicon dioxide layer is performed by
plasma etching techniques.

25. The method for fabricating a thermoelectric device in accordance with claim 22
wherein the step of polishing the surface of the plated copper is performed by
chemical and mechanical polishing techniques.

20 26. The method for fabricating a thermoelectric device in accordance with claim 19
wherein the step of disposing a first thermoelement comprises the sub steps of:

- a. sputtering a film of thermoelectric material onto the base structure;
- b. coating a photoresist layer with lateral dimensions equal to the dimensions
of first thermoelement;

- c. etching the photoresist layer using techniques selected from plasma etching and wet etching; and
- d. removing the photoresist by dissolving in organic solvents.

5 27. The method for fabricating a thermoelectric device in accordance with claim 19,
wherein the steps of disposing first and second phonon conduction impeding
mediums are performed by at least one technique selected from a group
consisting of micropipette dispensing techniques, pressure fill techniques and jet
printing techniques.

10 28. The method for fabricating a thermoelectric device in accordance with claim 19,
wherein the step of combining is performed by flip-chip backside-to-front aligners.

15 29. A method for fabricating a thermoelectric device, the method comprising the
steps of:

- a. forming a first base structure, the first base structure comprising a silicon
dioxide coated silicon wafer and a first solid metal electrode;
- b. adding a first thermoelement on the base structure;
- c. depositing and patterning a layer of photoresist over a preselected area of
20 the first base structure;
- d. depositing a layer of a second thermoelement over the structure formed
after step c, the polarity of the second thermoelement being opposite to the
polarity of the first thermoelement;

5

- e. removing the layer of photoresist by dissolving in organic solvents to form a second base structure;
- f. forming a third base structure by adding a first phonon conduction impeding medium over the first thermoelement and a second phonon conduction impeding medium over the second thermoelement of the second base structure; and
- g. combining the third base structure with the second base structure, the combination resulting in the formation of the thermoelectric device.